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Indirect effects of trait impulsivity on body mass

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ABSTRACT

Trait impulsivity has been suggested as a risk factor for weight gain. However, it is implausible that a construct that does not cover energy intake or expenditure affects fat mass directly. Instead, it is likely that eating-related variables mediate the effect of impulsivity on body mass. In the current study, a serial mediation model tested two eating-related variables (trait food craving and perceived self-regulatory success in weight regulation) as mediators of the relationship between trait impulsivity and body mass. Participants ($n = 432$, 88% female, 79% students) completed the *Barratt Impulsiveness Scale – short form*, the *Food Cravings Questionnaire-Trait-reduced*, and the *Perceived Self-Regulatory Success in Dieting Scale* (PSRS), in addition to providing sociodemographic and anthropometric data. Trait impulsivity did not correlate with body mass index (BMI), but was indirectly related to BMI via food cravings and PSRS scores. Specifically, higher impulsivity predicted more frequent food cravings, which in turn predicted lower perceived self-regulatory success in eating and weight regulation, which in turn predicted higher BMI. Findings suggest possible mechanisms that mediate the association between impulsivity and BMI. Importantly, they show that impulsivity can indirectly affect BMI via eating-related variables, even in the absence of a total effect. Longitudinal studies are needed that support these assumed causal directions.

1. Introduction

Impulsivity refers to a predisposition toward rapid, unplanned actions without regard to the negative consequences of these actions (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). It is considered a stable personality trait, which may manifest in maladaptive behaviors such as aggressive and self-injuring behaviors or substance use disorders (Moeller et al., 2001; Shaffer et al., 2004). Similarly, it has been proposed as a risk factor for weight gain and, thus, to be associated with overweight and obesity (Guerrieri, Nederkoorn, & Jansen, 2008). However, findings about an association between trait impulsivity and body mass index (BMI) have been fairly inconsistent and it appears that the magnitude of this relationship is very small (Meule & Blechert, 2016). Furthermore, as impulsivity is a construct that does not cover energy intake or expenditure, it is implausible that it affects fat mass directly. Rather, higher impulsivity likely leads to higher BMI through mediating mechanisms such as eating behaviors. In fact, several neural models of impulsivity suggest such linkages, for example, by proposing increased reward responses to food cues or deficient inhibition of the resulting craving experiences and appetitive behaviors (Stice & Yokum, 2016; van der Laan & Smeets, 2015).

Several cross-sectional studies examined indirect effects of impulsivity on BMI via eating behavior-related variables. For example, we recently found that the relationship between trait impulsivity and BMI was mediated by lower perceived self-regulatory success in weight regulation in children and adolescents (Meule, Hofmann, Weghuber, & Blechert, 2016). Similarly, Murphy, Stojek, and MacKillop (2014) found that the relationship between trait impulsivity and BMI was mediated by self-reported addiction-like eating as measured with the *Yale Food Addiction Scale* (YFAS) in a sample of predominantly female students. This finding was also replicated in a recent study in a more diverse sample (VanderBroek-Stice, Stojek, Beach, & MacKillop, 2017). Importantly, in all three of these studies these indirect effects were found although there was no overall relationship between impulsivity and body weight. That is, higher impulsivity was indirectly associated with higher body weight through lower perceived self-regulatory success in weight regulation or higher addiction-like eating symptomatology in the absence of a total effect of impulsivity on body weight.

An essential feature of addiction-like eating is the experience of frequent and intense food cravings and the difficulty to resist them (Meule & Kübler, 2012). In fact, scores on the YFAS are highly correlated with scores on the *Food Cravings Questionnaire-Trait* (Meule, Heckel, Jurowich, Vögele, & Kübler, 2014; Meule, Hermann, & Kübler, 2015; Meule, Müller, Gearhardt, & Blechert, 2017), higher scores of which indicate more frequent and intense food craving experiences. Thus, it appears that these measures capture strongly overlapping constructs. In turn, higher trait food craving scores have been implicated in lower self-regulatory success in weight regulation (Meule, Westenhöfer, & Kübler, 2011). Importantly, a recent longitudinal study revealed that higher trait food craving scores prospectively predicted decreased

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perceived self-regulatory success in weight regulation six months later in female students (Meule, Richard, & Platte, 2017). Moreover, higher trait food craving scores indirectly predicted increased BMI via decreased perceived self-regulatory success, thus supporting a possible causal chain (i.e., food cravings → perceived self-regulatory success → BMI).

The present study aimed to integrate these findings by testing a serial mediation model in a sample of predominantly female students. Based on the assumed causal directions tested in previous studies (e.g., impulsivity → addiction-like eating → BMI; Murphy et al., 2014; VanderBroek-Stice et al., 2017), an indirect effect of trait impulsivity on BMI via eating-related variables was examined. Specifically, based on the indirect effect of impulsivity on BMI via perceived self-regulatory success in weight regulation (i.e., impulsivity → perceived self-regulatory success → BMI; Meule et al., 2016) and the indirect effect of trait food craving scores on BMI via perceived self-regulatory success in weight regulation (i.e., food cravings → perceived self-regulatory success → BMI; Meule et al., 2017), we hypothesized that there would be an indirect effect of trait impulsivity on BMI via food cravings and perceived self-regulatory success in weight regulation (in serial order, i.e., impulsivity → food cravings → perceived self-regulatory success → BMI).

2. Methods

2.1. Participants

The data presented in the current paper are a re-analysis of a study on "food addiction", which was advertised as a study on eating behavior and impulsive reactions in certain situations (Meule et al., 2017). Participants were recruited in February and March 2015 via students' mailing lists at various universities in German-speaking countries (Germany, Austria, Switzerland, Luxembourg) by providing a link to the study's website at www.soscisurvey.de. The study included questions on sociodemographic and anthropometric data and several questionnaires. Only the measures included in the current analyses are reported here. Six-hundred and seventeen individuals started the study. Participants who were identified by the website's quality check to have answered questions too rapidly were excluded ($n = 16$). Moreover, data from participants who did not complete all measures were discarded ($n = 169$), leaving a final sample of $n = 432$ participants (88.4% female, $n = 382$). Most participants were students (78.9%, $n = 341$) and had German citizenship (82.9%, $n = 358$). Descriptive statistics of age and BMI are reported in Table 1. Most participants had normal weight (77.5%, $n = 335$, BMI = 18.5–24.9 kg/m^2) and few were underweight (6.90%, $n = 30$, BMI < 18.5 kg/m^2), overweight (11.6%, $n = 50$, BMI = 25.0–29.9 kg/m^2), or obese (3.90%, $n = 17$, BMI ≥ 30.0 kg/m^2).

2.2. Measures

2.2.1. Barratt Impulsiveness Scale – short form (BIS-15)

The German version of the BIS-15 (Meule, Vögele, & Kübler, 2011; Spinella, 2007) was used for measuring trait impulsivity. The scale consists of 15 items (e.g., "I act on the spur of the moment.", "I say things without thinking."), which are scored on a four-point scale ranging from 1 = *never/rarely* to 4 = *almost always/always*. Thus, total scores can range between 15 and 60. Higher scores indicate higher impulsivity. Internal consistency was $\alpha = 0.81$ in the current study, which is consistent with previous studies (Meule, Vögele, et al., 2011; Spinella, 2007).

2.2.2. Food Cravings Questionnaire – Trait – reduced (FCQ-T-r)

The German version of the FCQ-T-r (Hormes & Meule, 2016; Meule, Hermann, & Kübler, 2014) was used for measuring the frequency of food cravings. The scale consists of 15 items (e.g., "If I am craving something, thoughts of eating it consume me.", "If I give in to a food craving, all control is lost."), which are scored on a six-point scale ranging from 1 = *never/not applicable* to 6 = *always*. Thus, total scores can range between 15 and 90. Higher scores indicate more frequent and/or intense food craving experiences. Internal consistency was $\alpha = 0.95$ in the current study, which is consistent with previous studies (Hormes & Meule, 2016; Meule, Hermann, et al., 2014).

2.2.3. Perceived Self-Regulatory Success in Dieting Scale (PSRS)

The German version of the PSRS (Fishbach, Friedman, & Kruglanski, 2003; Meule, Papies, & Kübler, 2012) was used for measuring subjectively perceived success in eating and weight regulation. The scale consists of three items ("How successful are you in watching your weight?", "How successful are you in losing extra weight?", "How difficult do you find it to stay in shape?"), which are scored on a seven-point scale anchored not 1 = *successful/not difficult* and 7 = *very successful/very difficult*. Thus, total scores can range between three and 21. Higher scores indicate higher perceived self-regulatory success. Internal consistency was $\alpha = 0.71$ in the current study, which is consistent with previous studies (Fishbach et al., 2003; Meule et al., 2012).

2.3. Data analyses

Pearson correlation coefficients were calculated to examine relationships between age, BMI, BIS-15 scores, FCQ-T-r scores, and PSRS scores. A serial mediation model was calculated with PROCESS for SPSS (Hayes, 2013). This model is based on three linear regression analyses. In the first regression analysis, the first mediator (here: FCQ-T-r scores) is predicted by the independent variable (here: BIS-15 scores; path a_1 in Fig. 1A). In the second regression analysis, the second mediator (here: PSRS scores) is predicted by both the independent variable and the first mediator (paths a_2 and d_{21} in Fig. 1A). In the third regression analysis, the outcome variable (here: BMI) is predicted by the independent variable, the first mediator, and the second mediator (paths b_1, b_2, and c' in Fig. 1A). Path c' represents the direct effect of the independent variable on the outcome variable (here: the effect of BIS-15 scores on BMI when controlling for both mediators). The effect of the independent variable on the outcome variable without controlling for the mediators represents the total effect. Indirect effects were evaluated with 95% bias-corrected confidence intervals based on 10,000 bootstrap samples (cf. Hayes, 2013, p. 111, regarding the sufficient number of bootstrap samples).

Table 1
Descriptive statistics of and correlations between study variables.

$n = 432$	*M*	*SD*	Range	1	2	3	4	5
1. Age (years)	25.6	7.09	16–55	–	0.334 ($p < 0.001$)	−0.036 ($p = 0.450$)	0.035 ($p = 0.471$)	−0.095 ($p = 0.048$)
2. Body mass index (kg/m^2)	22.3	3.70	12.2–42.5		–	0.003 ($p = 0.946$)	0.208 ($p < 0.001$)	−0.439 ($p < 0.001$)
3. Barratt Impulsiveness Scale – short form	30.2	6.00	16–54			–	0.249 ($p < 0.001$)	−0.162 ($p = 0.001$)
4. Food Cravings Questionnaire-Trait-reduced	34.5	14.5	15–84				–	−0.523 ($p < 0.001$)
5. Perceived Self-Regulatory Success in Dieting Scale	12.4	3.85	3–21					–

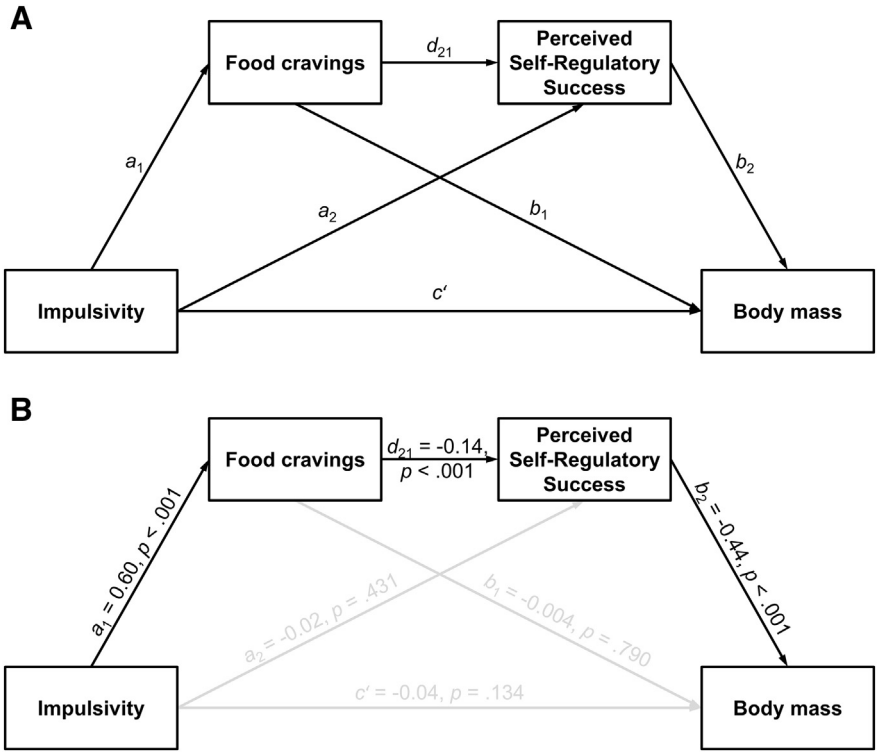

Fig. 1. Conceptual (A) and empirical (B) serial mediation model. There was an indirect effect of scores on the Barratt Impulsiveness Scale – short form (BIS-15) on body mass index (BMI) via scores on the Food Cravings Questionnaire-Trait-reduced (FCQ-T-r) and scores on the Perceived Self-Regulatory Success in Dieting Scale (PSRS). The other indirect effects (BIS-15 → FCQ-r → BMI and BIS-15 → PSRS → BMI) were not significant and there was no direct or total effect of BIS-15 scores on BMI.

3. Results

BMI was positively correlated with age and FCQ-T-r scores, negatively correlated with PSRS scores, and uncorrelated with BIS-15 scores. However, BIS-15 scores were positively correlated with FCQ-T-r scores and negatively correlated with PSRS scores. Finally, PSRS scores were negatively correlated with age and FCQ-T-r scores (Table 1).

In the serial mediation model, paths a_1, d_{21}, and b_2 were significant (Fig. 1B). Accordingly, there was an indirect effect of BIS-15 scores on BMI via FCQ-T-r and PSRS scores (effect coefficient 0.04, 95% CI [0.02, 0.06]). Paths a_2, b_1, and c' were not significant (Fig. 1B). Accordingly, the other indirect effects were not significant (BIS-15 → FCQ-r → BMI: effect coefficient −0.002, 95% CI [−0.02, 0.01]; BIS-15 → PSRS → BMI: effect coefficient 0.01, 95% CI [−0.02, 0.04]) and there was no direct (effect coefficient − 0.04, 95% CI [−0.10, 0.01]) or total (effect coefficient 0.002, 95% CI [−0.06, 0.06]) effect of BIS-15 scores on BMI (Fig. 1B). Including age, gender, and occupation (students vs. others) as covariates in the serial mediation model did not change results.

4. Discussion

In the current study, self-reported impulsivity was not correlated with BMI. However, and in line with previous findings (Meule, Hermann, et al., 2014; Meule et al., 2012), both variables were correlated with eating-related measures such that higher impulsivity and higher BMI were associated with more frequent food cravings and lower perceived self-regulatory success in eating and weight regulation. A serial mediation model revealed that there was an indirect effect of trait impulsivity on BMI via food cravings and perceived self-regulatory success. Specifically, higher impulsivity predicted more frequent and intense food cravings, which in turn predicted lower perceived self-regulatory success in eating and weight regulation, which in turn predicted higher BMI. Note that, in contrast to widely held beliefs about mediation testing, it is indeed possible to establish such indirect effects in the absence of a total effect (Hayes, 2013; Zhao, Lynch, & Chen, 2010). Thus, findings complement previous studies, which showed that eating-related variables mediated the relationship between trait impulsivity and BMI (e.g., Murphy et al., 2014; VanderBroek-Stice et al., 2017). They extend previous findings by suggesting that having an impulsive personality may increase the susceptibility for experiencing and giving into food cravings, which results in lower perceived self-regulatory success in eating and weight regulation and ultimately increasing body weight.

Although the current study provides some insights into the possible mechanisms that link trait impulsivity and body weight, several questions remain unanswered that may inspire future investigations. While eating-related variables mediate the relationship between impulsivity and body weight, it is unclear which mediators link impulsivity and these eating-related variables in the first place. For example, the specific mechanisms that determine why and under which circumstances higher impulsivity may lead to experiencing and giving into a food craving (and not to, e.g., craving for other substances or other addictive behaviors) remains to be elucidated. Parts of these questions may be answered by considering the multidimensional nature of impulsivity (e.g., self-reported trait impulsivity, motor response inhibition, delay discounting). For example, it has been shown that only specific facets of impulsivity were related to addiction-like eating and obesity (e.g., Mobbs, Crépin, Thiéry, Golay, & Van der Linden, 2010; VanderBroek-Stice et al., 2017). Similarly, different facets of impulsivity have been related to alcohol craving and these relationships depended on moderating variables such as perceived availability (Papachristou, Nederkoorn, Corstjens, & Jansen, 2012; Papachristou et al., 2013; Papachristou, Nederkoorn, Havermans, van der Horst, & Jansen, 2012). Although such findings exist, however, we feel that, to date, results on differential relationships between certain impulsivity facets with different types of craving or addictive behaviors and moderators thereof are too mixed to draw any straightforward conclusions. Finally, future research using the PSRS might also include items on the importance of

weight regulation (cf. Fishbach et al., 2003) as some individuals with high PSRS scores appear to be not concerned with their weight (Nguyen & Polivy, 2014) and, in these individuals, mediational pathways between impulsivity, craving and BMI might be different.

Interpretation of results is limited by sample characteristics, use of self-report, and the cross-sectional nature of the study. Specifically, samples in web-based studies are biased due to under-coverage and self-selection (Bethlehem, 2010) and the majority of participants in the current study were female students who had normal weight. Thus, although including age, gender, and occupation did not alter results, future studies are needed with a larger proportion of men and a larger variance in age, BMI, and education in order determine if findings similarly apply to men, older individuals, and people with obesity and lower education. Self-report measures are susceptible to bias and, thus, future studies may assess impulsivity with behavioral tasks, assess the occurrence of food cravings in daily life (e.g., with ecological momentary assessment), and measure fat mass objectively (e.g., with bioelectrical impedance analysis). Finally, longitudinal studies are necessary to support the assumed causal directions tested in the current analyses (Hagger-Johnson, 2016).

To conclude, the current findings suggest possible mechanisms (e.g., more frequent food cravings and, subsequently, lower perceived self-regulatory success in eating and weight regulation) that mediate the effect of higher impulsivity on higher body mass and may, thus, inspire theorizing on proximal (e.g., food cravings, dieting success) and distal (e.g., impulsive personality) determinants of weight gain. Importantly, such indirect effects are present even in the absence of a total effect of impulsivity on BMI. Thus, it appears that when a study fails to document a significant association between impulsivity and BMI (e.g., Hendrick, Luo, Zhang, & Li, 2012; Loeber et al., 2012), this does not preclude that impulsivity has an effect on body weight. Although such an effect may not be apparent, it may be indirectly observable when considering eating behavior-related variables.

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